R E P O R T R E S U M E S

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REPORT OF THE U.S. OFFICE OF EDUCATION - ROCHESTER INSTITUTE OF TECHNOLOGY SUMMER INSTITUTE IN INDUSTRIAL INSTRUMENTATION TECHNOLOGY, SUMMER, 1965.

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A SUMMER INSTITUTE WAS HELD FOR PROSPECTIVE TEACHERS OF INDUSTRIAL INSTRUMENTATION. CLASSES AND LABORATORY SESSIONS WERE CONDUCTED DURING 6 WEEKS OF 1965. THE PARTICIPANTS CONSISTED OF EIGHT TRAINEES FROM THE FACULTY OF POST-HIGH SCHOOL TECHNICAL INSTITUTIONS, ONE FULL-TIME PROFESSOR, AND TWO GUEST LECTURES. THE ACTIVITIES INCLUDED CLASS INSTRUCTION, FIELD TRIPS, AND LABORATORY EXPERIENCES. EVALUATION OF THE PROGRAM WAS MADE BY THE TRAINEES, THE LECTURERS, AND AN EXTERNAL COMMITTEE FROM THE INSTRUMENT SOCIETY OF AMERICA. THE RESULTS INDICATED THAT A SUMMER INSTITUTE CAN BE USED EFFECTIVELY TO PREPARE PROSPECTIVE INDUSTRIAL INSTRUMENTATION TEACHERS. DEVELOPMENT OF A FUTURE PROGRAM THAT WOULD EXTEND THE TRAINING OVER 2 SUCCESSIVE SUMMER SESSIONS WAS SUGGESTED, AND RECOMMENDATIONS WERE MADE TO MAKE AVAILABLE MORE APPARATUS TO PROVIDE EACH PARTICIPANT EXPERIENCE WITH ALL OF THE BASIC APPARATUS. (AL)

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Rochester Institute of Technology

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MECHANICAL DEPARTMENT

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Report of the

U. S. Office of Education - Rochester Institute of Technology

Summer Institute in Industrial Instrumentation Technology,

Summer, 1965

1. The program for prospective teachers of instrumentation courses at the technical institute level was conducted at the Rochester Institute of Technology, Rochester, New York, during the six-week period beginning July 12 and ending August 20, 1965. In all essential details, the program was carried out according to the attached brochure, Inclosure #1.

2. The primary objectives of the Institute were:

   a. To assist faculty members of post-high school technical institutions in improving their technical competence in the area of industrial instrumentation.

   b. To provide prospective teachers of industrial instrumentation with both the basic knowledge and the principles involved in the presentation of such programs.

   c. To evaluate the use of new laboratory equipment to promote the teaching of:

      (1) Basic concepts

      (2) The relatively few fundamentals which are involved.

   d. To test the effectiveness of some new teaching techniques.

   e. To give the student both familiarity with the apparatus and confidence in his own competence by having him build each major laboratory unit, as well as many minor ones.

3. The classes were conducted by Professor Austin Fribance for the six-week period, essentially according to the schedule shown in Inclosure #1. Laboratory sessions were held both in the classroom at 50 Main Street West, Rochester, or at the laboratories of the Mechanical Department of R.I.T. at South Washington Street, Rochester.

4. One of the original objectives of the program had been to determine whether those with electronic backgrounds could quite readily be converted into effective teachers of industrial instrumentation courses. The second choice for class members was those who had good preparation in the basic courses in Physics.

5. Because of the short time available to recruit a class, (Inclosure #2), the selection was modified to include those who had immediate need for the program because they were scheduled to begin teaching instrumentation courses in the following school year, or were to oversee the installation and operation of instrumentation programs. Because of the immediate need of several of the class, it was felt that increased emphasis on principles and teaching were more necessary than the laboratory programs which could be studied and considered when the student had returned to his home institution. However, this change in emphasis did not alter in any significant way the evaluation of the laboratory program or the manner of presenting the material. It did result in more of the work being given as demonstrations than would have been the case if the full complement of laboratory equipment had been available.

6. The special nature of the laboratory apparatus made it impossible to obtain the desired four sets of equipment - one set for each pair of students. Because of the date at which the program was approved, there was time to obtain but one of each of the major units. With most of the designs, only "one of a kind" had been built for use in the Institute because of the belief that not more than two or three might be in attendance, if, in fact, the Institute were held at all.

7. By stressing only fundamentals of physics and their application in the areas of measurements and control, it was possible to teach the basic principles of all the common industrial measuring devices, as well as those of automatic control.

8. By emphasizing definitions and common relationships, it was possible to take the group through the factors influencing the response of the various types of transducer elements. Then to the time constant and phase shift relationships of components were added the effects of feedback and control relationships. Emphasis was placed on the "gain" of the individual components, and the various ways in which it might be expressed.

9. Every attempt was made to give the participants a chance to question and discuss the principles and the methods of presentation. The small size of the class and the active interest of the members made it possible to carry on in a very informal manner, to the benefit of all concerned.

10. The classroom work involved frequent problems and written assignments to determine the degree of mastery of the material. Because of the size of the class, frequent questioning made it possible to detect troublesome areas almost as soon as they developed. It is quite worthy of note that all members of the institute were present for every session, with one exception of one session when the individual was excused for personal reasons. The attendance and the active participation of all were most gratifying.

11. Three field trips were conducted:

    a. The entire group was given a tour of the hydraulics laboratory of the Taylor Instrument Companies. This was coincidental with the lectures on flow measurements.

    b. For purposes of illustrating measurements, telemetering, and control, there are few plants which are better than the Bethlehem Steel Company Plant at Lackawanna, New York. Almost all elements of the plant were visited with excellent guides to discuss the various processes and their control problems.

    c. The third visit was to the ISA Summer Conference at Geneva, New York, where some of the new teaching equipment was available for study and evaluation of its use in a teaching program.

12. The use of the component method of creating transducers, transmitters and the various other components which are required both for measurement and control was well established. The employment of very simple amplifying elements made it possible to show what each component in the feedback loop was doing, and just how it functioned in the system.

13. Commercial apparatus was employed in many instances to show how the theoretical approach of the laboratory equipment had been modified to meet industrial requirements of long life, accuracy, and mechanical strength. Commercial equipment is not designed for its utility in teaching and instruction, and cannot be used as effectively for instructional purposes as equipment which is especially designed for the purpose.

14. Two guest lecturers participated:

    a. Professor Frank B. Moore of Pennsylvania State University who discussed the detection and measurement of radioactive materials.

b. Henry Stoll, Nanager of Flow Measurements, Taylor Instrument Companies, Rochester, N.Y., who discussed fluid flow measurements.

15. A strong laboratory program is of the greatest help in reinforcing the teaching of principles; particularly when the apparatus can be completely assembled by the student. Repeated use of the same components to create different transducers is also most effective in demonstrating how few are the principles and how widespread their application.

16. It was a delight to teach the Instrumentation Institute. It was also most gratifying to find that the policy of teaching fundamentals with some new concepts was sound and practicable.

17. RESULTS OF THE INSTITUTE

a. With the background of those who were participants in the Institute, the two subjects of Measurements and Control involve too much material if one is to give the best treatment of the subject. A six to eight-week program, in successive years, would provide a better approach to the subject.

b. Those with the best background in physics and electronics or electricity, were able to master the material best; but all were able to do so. In fact, the class itself was most definite on this matter, with emphasis on fundamentals and the use of special laboratory equipment which made the principles of operation more evident, those with a mechanical background were not at a serious disadvantage.

c. Mastery of principles takes longer to teach than does the use of "the little black box". However, this would be only a temporary disadvantage.

d. The use of special laboratory equipment (Hickok Teaching Systems for the most part), made it possible to teach far more effectively than would have been the case with commercial apparatus.

e. Commercial apparatus should be used in conjunction with the special laboratory apparatus for the sake of relating theory and practice, and acquainting the instructor (and eventually the student) with the manner in which theory is translated into practice.

f. Visits to industrial or commercial installations should be incorporated into future programs because they facilitate the teaching of the problems which are involved in obtaining valid measurements which must precede effective control. Guest lecturers make definite contributions to such a program.

g. Because of the complexity of the subject of Industrial Instrumentation and the factors of several disciplines which are involved, there is no time to teach other than fundamental principles. There are only a few basic principles which are used over and over again with slight modifications to meet special conditions.

18. CONCLUSIONS:

a. A summer institute can be used very effectively to prepare in-service instructors (at the post-high school level), who are versed in the basic sciences, to teach programs of industrial instrumentation and control.

b. Two six to eight-week periods, with at least six class hours per day, should be used to teach the two phases of the subject:

    1. Measurements and Transducers.
    2. Automatic Control.

c. These programs should be given in successive years. For the average student, there is too much to be mastered in a single summer institute.

d. Where the emphasis is on the teaching of fundamental concepts as opposed to hardware, those individuals who do not have a strong electronic or electrical background are not at a serious disadvantage.

e. The use of special laboratory equipment aids greatly in teaching the principles which are employed by the various types of transducers and measuring devices.

f. Commercial apparatus should be used only in conjunction with special laboratory equipment, to show the changes in translating theory into practical equipment used in industry.

g. The special Hickok Laboratory equipment was most helpful in illustrating and teaching principles.

h. The use of guest lecturers who are specialists in their fields is most helpful.

19. RECOMMENDATIONS:

a. That in the future, two six or eight-week sessions given on successive years, be employed rather than the single six-week program.

b. Enough laboratory equipment be made available so that each pair of participants can construct, employ and otherwise use all of the basic apparatus.

c. That special laboratory apparatus, such as the Hickok equipment, be used in conjunction with pertinent commercial apparatus.

d. Problems of control not be more advanced than can be treated by means of the "frequency response" method.

e. Because the instructor is the key figure in the presentation of the program, great thought should be given to his selection.

Respectfully submitted,

Austin E. Fribance

Austin E. Fribance, Professor
Mechanical Department,
Rochester Institute of Technology

INSTRUCTION

The classes will be conducted by a regular instructor. He will be assisted by five guest lecturers with wide industrial experience, who are also extremely capable educators.

The regular class, laboratory, and discussions will be conducted by Professor Austin E. Fribance of the Mechanical Department of the Rochester Institute of Technology. As consultant to the Instrument Society of America in the development of the U.S. Office of Education publication "Industrial Instrumentation Technology," he carried out most of the basic research and prepared the final curriculum which forms the basis for the program.

Professor Fribance has served as educational consultant for Hickok Teaching Systems as "program developer" for national meetings of the Instrument Society of America. He has served as Guest Lecturer at Oklahoma State University, and the Graduate School of Rutgers State University. He is also the author of two texts in the field of measurement and control.

STIPENDS AND ALLOWANCES

Because of the present wording of existing legislation governing grants by the United States Office of Education, there are NO funds available either for stipends and allowances. Neither are there funds for travel. All such expenses must be obtained from the student's sponsoring institution.

TUITION, FEES, AND HOUSING

No tuition will be charged by the Rochester Institute of Technology. Books and supplies will be provided for each student in attendance. No fees will be charged.

Living accommodations may be secured at the Men's Dormitory of the Rochester Institute of Technology which is directly across the street from the instructional facilities which will be located at 50 Main Street West (downtown), Rochester. It is expected that a room at the dormitory and board at local restaurants may be obtained for approximately $60.00 per week.

If wives or children accompany the enrollee, the individual will have to make his own arrangements for accommodations. The dormitories are not set up for use by family groups. However, apartments and motels are within 1000 feet.

Regularly assigned classrooms will be air conditioned.

OBJECTIVES

The primary purposes of the Institute are three:

1. To assist faculty members of post-high-school technical institutions in improving their technical competence in the area of industrial instrumentation.
2. To provide prospective teachers of industrial instrumentation programs with both the basic knowledge and the principles involved in the presentation of such programs.
3. To evaluate the use of new laboratory equipment to promote the teaching of (a) basic concepts and (b) the relatively few fundamentals which are involved.

Only one program will be offered. There are no options or electives. The program will make full use of the student's time.

ELIGIBILITY AND APPLICATIONS

Selection of applicants will be based on the following criteria:

1. The applicant is now engaged in teaching industrial instrumentation courses, but desires to increase his efficiency.
2. The applicant has had experience in teaching electronics or physics at the post-high-school level.
3. There are teaching assignments available in industrial instrumentation courses provided the applicant can obtain the additional experience.
4. The applicant has studied electronics or physics (as majors in a baccalaureate program).
5. Only 20 appplicants will be accepted for the program. However, all appplicants will be informed at the earliest possible date.

It is believed that the program will be far too rapid for the average student who does not have a good background in electronics and electrical devices.

ACADEMIC CREDIT

Successful completion of the program will entitle the participant to eight semester-hours of graduate credit, which will be awarded by R.I.T., provided that the individual already possesses a baccalaureate degree.

The successful completion of the program will be based upon:

a. active participation in the daily work of the program;
b. satisfactory, or better, results on quizzes or examinations; and
c. satisfactory, or better, work in the laboratory, the required laboratory reports, and the evaluation of the laboratory equipment.

COURSE CONTENT

Outline of Program

FIRST WEEK

1. Basic Measuring and Recording Devices . . . 2 days
   Recorder and X-Y Plotters
2. Pressure-measuring Devices, Mechanical . . 1 day
   Manometers
   Elastic Membranes—bellows, Bourden Tubes
3. Pressure Transmitters, Pneumatic . . . . . 2 days
   Pneumatic Relay Amplifiers, Direct and Reverse Acting
   Pressure and Differential Pressures

SECOND WEEK

4. Liquid Level Determination, Mechanical . . . 1 day
5. Flow Measurements, Mechanical . . . . . 2 days
   Rotameters, Orifice Plates, Flow Nozzles, Venturi Tubes
6. Temperature Measurements, Mechanical . . 2 days
   Solid-filled, vapor pressure, gas systems

THIRD WEEK

7. Resistance and Capacitance . . . . . 1 day
   Thermal, Liquid
8. Time Constants . . . . . 1 day
9. Potentiometric Measurements . . . . . 1 day
10. Electrical Bridges . . . . . 2 days
    Resistance balance
    Current balance
11. Photo-electric Effects . . . . . 1 day
    Photo-resistive, photo-voltaic
12. Electrical Transducers . . . . . 2 days
    Pressure to current or emf
    Position to emf or current
    Linear Differential Transformers
    Stress gages

FOURTH WEEK

13. Electrical Pressure Measurements .....1 day
    Force and movement balance
14. Electrical Temperature Measurements ....1 day
    Voltaic, resistance
15. Electrical Flow Measurements .....1 day

FIFTH WEEK

16. Pneumatic Controllers and Valves .....1 day
    On-Off
17. Pneumatic Controllers, Proportional .....1 day
18. Pneumatic Controllers, Prop + Rate .....1 day
19. Pneumatic Controllers, Prop + Reset + Rate 1 day

SIXTH WEEK

20. Electrical Controllers, On-Off .....1 day
21. Electrical Controller, Proportional .....1 day
22. Frequency Response of Components .....2 days
23. Feedback Block Diagrams .....1 day

SCHEDULE

DAILY

a. 9:00-10:30 Physical Principles

10:45-12:00 Discussion of experiment and relationship to industrial equipment

1:00- 3:00 Perform experiment

3:15- 4:15 Evaluate equipment and experiment (Class discussion)

Assigned homework in Physics and writing up report

b. Period of 6 weeks, 5 days/week
6 hours/day in class plus 3 hours outside work

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Office of Education
Division of Adult and Vocational Research

Vocational Education Act of 1963
(P.L. 88-210, Sec. 4(c))

PROJECT SUMMARY - ERD-373-65 5-0179
Contract No. OE-6-85-011

TITLE: Industrial Instrumentation Technology for Instructors in Junior Colleges and Technical Institutes.

PRINCIPAL INVESTIGATOR: Dr. Austin E. Fribance, Professor
Mechnical Department

INSTITUTION: Rochester Institute of Technology, Rochester, New York

FEDERAL FUNDS REQUESTED: $20,595

DURATION: *Beginning, July 1, 1965 Ending, August 31, 1965

Objectives:
1. To assist faculty members of electronics or physics departments of junior colleges or post high school technical institutions in improving their technical competencies in the area of industrial instrumentation.
2. To evaluate the program to provide prospective teachers of industrial instrumentation with both the basic knowledge and the principles involved in the presentation of instrumentation at the level set by Instrumentation Technology (OE-80033).
3. To evaluate the use of new laboratory equipment to promote the teaching of (a) basic concepts and (b) the relatively few fundamentals which are involved.

Procedures:
1. Approximately twenty (20) enrollees will be selected from persons who are now employed as teachers of electronics or physics in technical institutes or junior colleges and whose home institutions plan to offer courses in instrumentation and automatic control.
2. One full-time professor and six guest lecturers will provide the enrollees with six weeks of training, including both lecture and laboratory sessions.
3. The various aspects of the training program will be evaluated by the enrollees and the lecturers as well by an external committee from the Instrument Society of America.

*Confirmation of letter contract dated July 1, 1965

Class list - Summer Institute

James Kolisar
3212 Jane Street
Pittsburgh, Pa.

Richard Miller
15 W. Main Street
Canton, New York

Peter Nevaldine
Canton, New York

Lowell McCaw
Pultneyville, New York

Brian Shutts
1102 Michigan Street
Midland, Michigan

Delbert McKee
Morrisville, New York

Joseph Cuerdon
283 Stevenson Blvd.
Buffalo, New York

Mel Martin
331 North 85th Street
Birmingham, Alabama